

TYPHOON CARMEN

The genesis of Typhoon Carmen provides an interesting example of the interaction of two synoptic features in generating a tropical cyclone. These features began interacting on 7 August 1978. On that day, Guam's surface winds shifted from easterly to southwesterly as the southwest monsoon surged well east of its normal habitat. Metsat imagery showed a noticeable upsurge in convective activity along and to the south of the low level monsoon trough, the axis of which now extended from Southeast Asia across the Philippines and over the western North Pacific to near the dateline. In Guam's vicinity, southwesterly flow persisted, deepened and strengthened. At 081200Z Guam's gradient level wind was 20 kt (10 m/sec) from the southwest.

During the same time frame, a Tropical Upper Tropospheric Trough (TUTT) northwest of Guam was deepening southward. Satellite derived upper-air winds at 081200Z confirmed considerable divergence existed south and east of the TUTT overlying the monsoon trough just north of Guam and definite signs of tropical cyclone organization were appearing. Six hours later, Guam's gradient wind had increased to 31 kt (16 m/sec) out of the southwest.

For the next day, this upper-level/lower-level interaction persisted and the developing disturbance, one of many along the monsoon trough discussed in the daily Significant Tropical Weather Advisory (ABEH PGTW), was written as having fair to good development potential. A formation alert was issued at 100156Z and two subsequent aircraft reconnaissance missions showed a minimum sea level pressure of 1004 mb and 25 kt (13 m/sec) estimated maximum surface winds. The surface center, however, was difficult to fix and the decision was to reissue the alert at 110134Z. Three hours later, however, aircraft data reported a 992 mb central pressure. Subsequently, the first warning was issued at 110600Z with 40 kt (21 m/sec) intensity. Meanwhile, the activity in the monsoon trough had also rapidly organized in another area; Tropical Storm Della was forming just east of the Philippines.

The TUTT's influence on Carmen continued beyond her early developmental stages. TUTT interaction also influenced her track and affected her size and intensification rate. Initially, Carmen's track was expected to be climatological since the overall synoptic environment in which Carmen was situated was typical of the August climatology. A strong, mid-tropospheric, subtropical ridge existed north of her and Carmen was forecast to follow a west-northwest track. In actuality, Carmen moved erratically for one day and then accelerated to the north-northwest. It appears that upper-level steering from southeasterlies east of the TUTT was a major influence on her track.

The TUTT also influenced Carmen's development rate. At 120000Z, Carmen was beginning to accelerate to the north-northwest with an intensity of 55 kt (28 m/sec). Three days later she had only intensified to

80 kt (41 m/sec) - an intensification rate which was half of the average rate for August cyclones. A partial explanation for this slow intensification was the fact that Carmen had a faster than average forward speed of 16 kt (30 km/hr) during this period and also that she was part of a two storm situation (Fig. 3-9). However, it is equally possible that the TUTT (still west of Carmen) also had a part in influencing Carmen's slow intensification rate and small size by restricting upper level outflow in her western and southern quadrants (Figs. 3-9 & 3-10). The 200 mb analyses indicated that the TUTT moved with Carmen and strengthened from the 11th to the 14th.

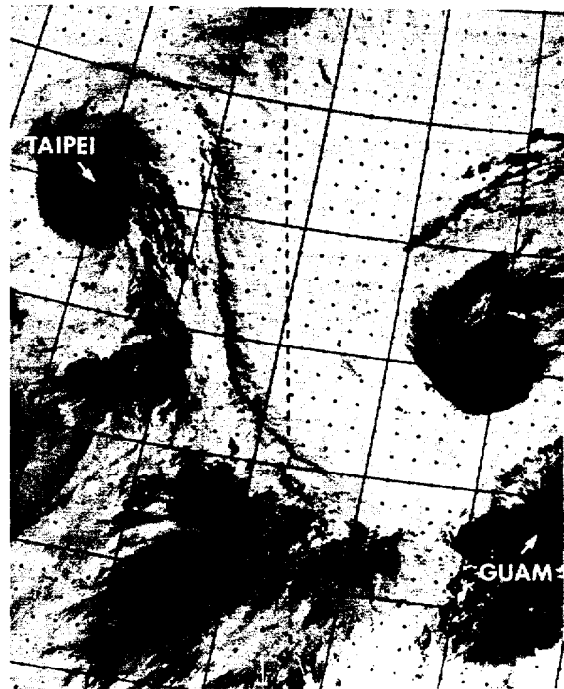


FIGURE 3-9. Infrared image of Typhoon Carmen (right) and Tropical Storm Della (left), 12 August 1978, 2134Z. (DMSP imagery)

By 151200Z, the TUTT axis had curled to the south of Carmen. Satellite imagery at this time (Fig. 3-11) showed a more symmetrical typhoon but small in areal extent. The strong mid-tropospheric subtropical ridge still existed to the north and Carmen was expected to track westward into the China coast. However, a high pressure cell was building ahead of Carmen over the Asian coast. By the 16th, Carmen was caught in a weak steering flow between high pressure cells to the east and west and, for three days, Carmen looped erratically and weakened in intensity. On the 17th, a developing short wave trough was analyzed over the Asian mainland and warnings reflected

recurvature toward Korea. At 181200Z, Carmen did begin to track northward and eventually dissipated over Korea. Despite Carmen's erratic behavior, 24-hour forecast errors matched the average for the year.

During her lifetime, Carmen was responsible for considerable damage. Before dissipating over South Korea, she caused widespread flooding, a reported 21 deaths and \$3 million worth of property damage. Saipan, affected by Carmen in her formative stage, reported flooding and property damage and was designated a national disaster area. At maximum intensity of 80 kt (41 m/sec) on August 15, Carmen passed over Okinawa about

26 nm (48 km) north of Kadena AB with little damage to DoD facilities.

The disturbance in the monsoon trough that eventually became Carmen was similar to many others that did and did not develop. And, of those that did develop, many only reached the monsoon depression stage. The difficulty in determining the development potential of these monsoon disturbances affected the timeliness of issuance of the formation alert and initial warning on Carmen. Near perfect forecasting to meet customer requirements would have allowed the initial warning to be issued 48 to 72 hours prior to the actual 110600Z issuance.

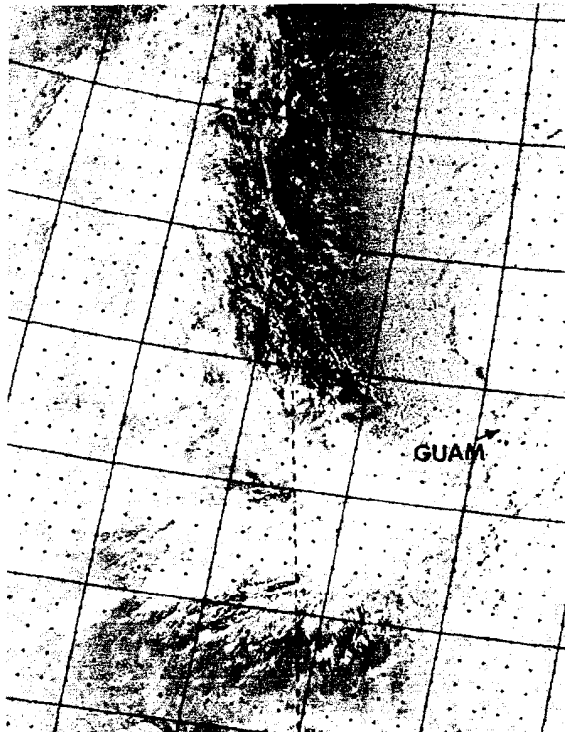


FIGURE 3-10. Restricted upper-level outflow over Carmen's western and southern quadrants, 11 August 1978, 2243Z. (DMSP imagery)

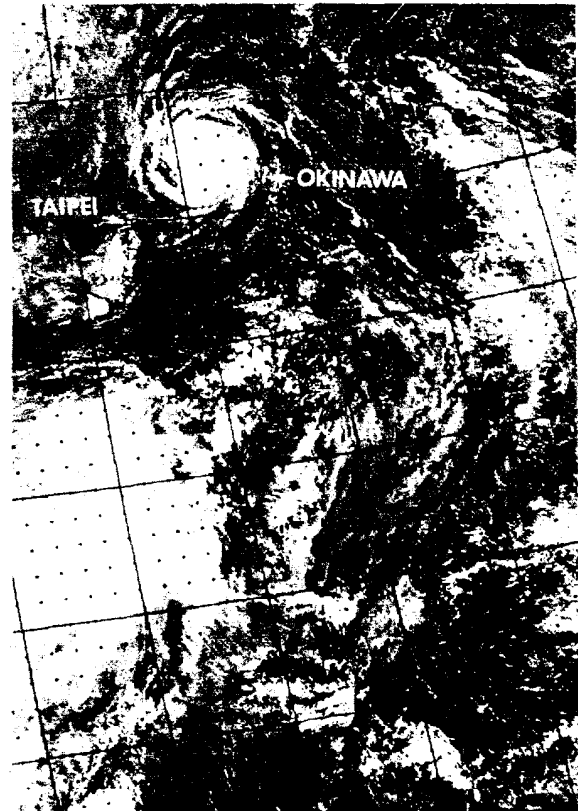


FIGURE 3-11. Carmen's small areal extent, 15 August 1978, 1505Z. (DMSP imagery)